Technology Opportunity

The Directional Electrostatic Accretion Process

The Directional Electrostatic Accretion Process (DEAP) is a manufacturing technology to create metal products without molds, dies, or tooling. DEAP creates metal shapes by building up or accreting them from tiny electrostatically charged molten metal droplets (see fig. 1). Although this manufacturing concept was envisioned as a method of manufacturing in space, where tooling is not available, the process can be applied to a number of Earth-based applications as well.

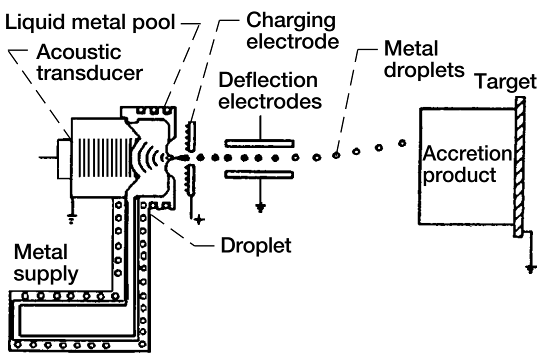

Figure 1.—The accretion concept.

Potential Commercial Uses

- Low-volume toolless manufacturing
  - DEAP can evolve into a full-scale manufacturing system capable of creating metal parts for low-to-moderate volume production. It can be used in the development of new products that would not be economically viable by other methods. The “Art to Part” approach can reduce costs by producing a part within hours of its design.
- Electronics manufacturing applications
  - Electronic board fabrication: Conductive paths are made by depositing metal on the circuit board instead of by using chemical etchants and masking compounds.
  - Circuit soldering: Small quantities of solder are delivered at precise locations without relying on solder mask tools.
  - Production of ball grid arrays and micro ball grid arrays: Tiny metal balls replace circuit pins and sockets for denser circuits.
- Composing special materials
  - Rapid solidification: Tiny molten metal droplets solidify so quickly that they produce so-called glassy metals which exhibit unusual properties.
  - In situ alloys: Accurate control of the alloy concentration allows properties to be manipulated. High strength or toughness may be placed only where needed.
  - Composite materials: Materials that could not otherwise be combined can be formed by accretion. Materials with vastly differing melting points can be composed.

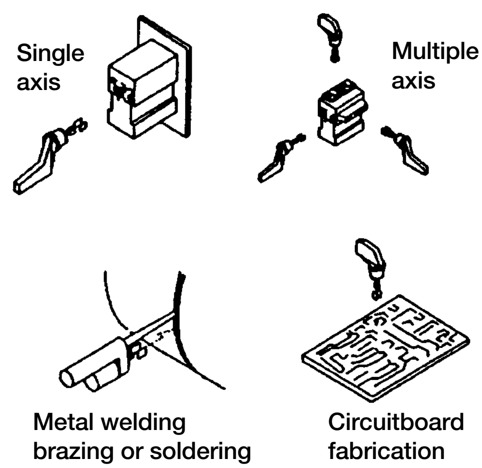

Figure 2.—DEAP applications.

Benefits

Most of the nonrecurring cost of production is the time and labor required to produce the tooling. Any means that eliminates tooling reduces the upfront cost of production and its amortization over many units; therefore

- A nontooled product can be produced profitably in smaller quantities.
- DEAP would allow U.S. industries to take advantage of markets for low- and moderate-volume production, thereby offsetting the loss of high-volume industries to offshore production.
- Precise placement of solder eliminates the need for physical masks and eliminates the chemicals for mask application and removal, thus making the process inherently cleaner.

The Technology

The process uses acoustic radiation pressure to eject droplets from a pool of liquid metal without using a nozzle. The droplet size is controlled electronically and each droplet is ejected on command. Each droplet is electrostatically charged as it is ejected, so the droplet's trajectory can then be manipulated by electrostatic fields. Like an electron beam in an oscilloscope, each droplet can be precisely placed on an accretion target. By using a computer to control the placement of each drop, the system can build up an entire freestanding structure. Thus, an object can be completely created without the use of molds, dies, or tooling.

Options for Commercialization

U.S. Patent Number 5520715 has been awarded (a second patent is pending). NASA Lewis will provide technical support for the commercial development of the technology. Seeking partnership agreements and/or licensing of the patent.

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Key Words

Accretion
Free-form fabrication
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Ball grid array
Printed circuit board

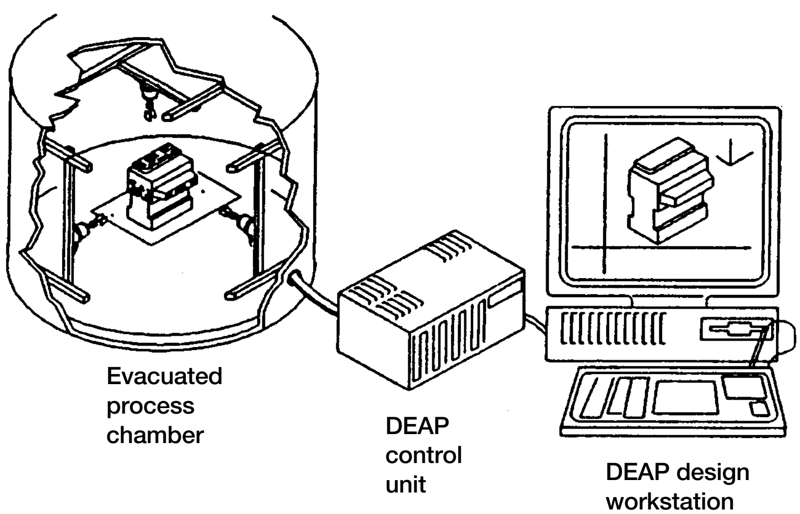

Figure 3.—DEAP manufacturing system.

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